A POPULATION-LEVEL APPLICATION OF IMMUNOCONTRACEPTION AND HERD REDUCTION TO WHITE-TAILED DEER

A Research Proposal

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EXECUTIVE SUMMARY

Immunocontraception (IC) in combination with population removals via relocation may be useful for managing deer populations in human-developed settings. However, this combination of management techniques has not been thoroughly studied in free-ranging, non-insular deer populations. Herein, we propose to study a deer population in as it undergoes an initial reduction and subsequent maintenance at a stationary level (i.e., with no population growth) with a single-dose, multi-year IC vaccine (i.e., SpayVac™). This multi-year study will entail population modeling, population reduction, deer capture and treatment with SpayVac™, gathering of survival and emigration data, and a refinement of population models using the adaptive management process. Anticipated benefits include insight into whether such a program may be useful for other communities, gathering of valuable human effort data, and additional information that deer biologists can use to understand human-deer-environmental interactions in developed areas.

INTRODUCTION

During the past decade, immunocontraception (IC) using porcine zona pellucida (PZP) antigens has been studied experimentally in white-tailed deer (*Odocoileus virginianus*). Some formulations of PZP-based immunocontraceptives are registered as investigational new animal drugs with the U.S. Food and Drug Administration (FDA) and have been used in field trials. Although not yet approved by the FDA, there is tremendous potential and public desire for using IC to manage deer populations in suburban or protected settings where lethal methods are not desirable (Messmer et al. 1997, Stout et al. 1997, Grandy and Rutberg 2002).

Because early applications of PZP required an initial treatment of an individual doe followed by annual boosters to prevent fawn births (Turner et al. 1992, Turner et al. 1996), the foremost concern about using IC for deer management has been the high cost of deer capture. SpayVac™, a new IC vaccine based on PZP, has recently been developed by researchers in Canada (Fraker et al. 2002) and is currently undergoing FDA testing. SpayVac™ provides multi-year contraception with a single dose, thereby overcoming the need for annual recapture of does for IC treatments (Appendix A). This should decrease costs for IC programs considerably, thereby increasing even further its attractiveness as a potential deer management method.

Immunocontraception has primarily been studied in either captive populations (Turner et al. 1992, Turner et al. 1996) or on islands (Fraker et al. 2002). A few investigators have assessed IC in free-ranging populations that mirror conditions under which IC may be used for future deer management (Rudolph et al. 2000, Walter et al. 2002). However, no efforts have been made to determine whether entire populations of free-ranging deer can be effectively managed using IC. Such research is crucial to forecast the potential cost and feasibility of IC for deer management.

Because IC will not reduce overabundant deer populations immediately, numerous scientists and deer managers have advocated using population reduction in combination with contraception to manage deer populations. Deer can first be captured and treated with IC when populations are high and capture effort per treated deer is low (Nielsen et al. 1997*a*, Rudolph et al. 2000). Then, during the same capture season, untreated deer can be removed to reduce the population to a level that may be more tolerable to those desiring fewer deer. Such an integration of methodology is beneficial for 2 primary reasons: (1) it allays concerns about current deer damage by reducing population abundance; and (2) after the initial removal, IC provides a long-term, non-lethal solution. Further, IC may not be viewed by some as cost-effective or acceptable if not used in conjunction with an initial reduction. Therefore, removal may be a necessary component of many IC programs in the future.

The process of adaptive management (Holling 1978, Walters 1986, Nielsen et al. 1997*a*) provides a potentially viable framework for implementing removal and IC in a free-ranging deer population. The adaptive management approach relies on first creating models to focus management and then implementing management in an experimental context. Data collected during research and management activities are then used to refine program objectives. Arguably, using this approach to manage deer using removal and IC is preferable to other methods, such as blindly treating a specified proportion of does based on suggestions from the literature (e.g., treating >90% of does in healthy populations; Swihart and DeNicola 1995, Nielsen et al. 1997*a*).

STUDY GOAL AND OBJECTIVES

Our goal is to study a free-ranging, non-insular deer population undergoing an initial reduction and subsequent maintenance at a stationary level (i.e., with no population growth) with a single-dose, multi-year IC vaccine (i.e., SpayVac™).

Our objectives are to:

1. Model deer population dynamics and determine number of does to treat with SpayVac™ to result in zero population growth over time following a reduction of deer.

2. Capture and treat with SpayVac™ the necessary number of does.

3. Remove the required deer (bucks and does) from the population using capture and relocation.

4. Quantify vital demographic rates and movements of the deer population (e.g., population abundance, survival, emigration, and local movements).

5. Assess effectiveness of SpayVac™ in individual treated does.

6. After one year of data collection, refine the population model and capture/treat with SpayVac™ additional does to maintain zero population growth over time.

7. Quantify human effort necessary to implement IC in combination with removal.

METHODS

The study will begin in early winter, given procurement of adequate funding and all necessary permits, and will require 2 winter seasons of deer capture and treatment with SpayVac™ (Appendix C). An additional 2 years of distance sampling surveys will be useful to assess efficacy of IC to stabilize population growth. Six months will then be allowed for final data analysis and report preparation.

Estimating Population Abundance and Herd Composition

We will use distance sampling (Buckland et al. 1993) to estimate deer population abundance during November of each study year. We will use methodology similar to that used during distance sampling surveys we routinely conduct (Appendix B). During distance sampling surveys we will determine herd composition by separating deer into adult buck, adult doe, and fawn age-classes. Fawns will be considered as recruits into the population at this time.

Population Modeling I: Determining Number of Does to Contracept in Winter 2003-04

Following distance sampling surveys in November 2003, we will model growth of the deer population by November using empirical demographic data (i.e., sex/age information from distance sampling surveys) and assumed rates from the wildlife literature. We will create a population model that accounts for new fawn recruits, removals and mortality, and assumes emigration equals immigration (i.e., no net population exchange between the community and the surrounding environment). Number of does to treat with IC to maintain zero population growth by November will be calculated based on predicted population growth following removal. This estimate will be the number of does to treat with SpayVac™ during the winter capture season.

Capture and Handling

The number of does to treat with SpayVac™ to maintain zero population growth will be captured using darting and drop nets during specified months during winter and at the same time during the following winter. Both darting and drop nets will focus on capturing does only; however, occasionally bucks will be captured under drop nets and released immediately. Darting from elevated stands or vehicles will be used because it allows for opportunistic and efficient capture (Kilpatrick et al. 1997). Project personnel will use dart guns to deliver single-use, wire-barbed darts (2 cc) to the flank region of deer. Deer will be injected intramuscularly with a mixture of the immobilizing agents Telazol (a mixture of Tiletamine HCl and Zolazepam HCl, 4 mg/kg) and Rompun (Xylazine HCl, 2 mg/kg). All immobilizing drugs will be procured and dispensed by a local cooperating veterinarian. Darts may be equipped with a radiotransmitter to facilitate tracking if deer move out of visual range before becoming immobilized. Darted deer will be recovered via radiotracking or by continuously observing the deer until the drug takes effect.

Drop nets (Ramsey 1968) will also be used, as they can capture multiple deer in one net drop. Two sizes of drop nets will be used, 30 × 30 ft and 60 × 60 ft. Nets will be suspended 8 ft above ground by 4 corner poles and a center pole. The net will be fastened to the poles using a trigger system to allow project staff to release the net from a distance >30 m from the net. When deer come to feed upon bait under the center of the net, it will be released. Deer captured in drop nets will be restrained and given a hand injection of the immobilizing agent Ketaset (Ketamine HCl, 10 mg/kg).

Upon restraint and immobilization, deer will be handled similarly regardless of capture technique. Deer will be aged, weighed, measured, and assessed for injuries. Deer will be given plastic ear tags and permanent identification transponder (PIT) tags for identification purposes. Deer (both adult and fawn does) will be given a single dose of SpayVac™ delivered intramuscularly in the rump with a hand syringe (Fraker et al. 2002). To ensure that SpayVac™-treated does are not accidentally consumed by humans, tags marked "do not consume, experimental animal treated with PZP" will also be fixed to deer. Deer will then be released at the capture site.

Human effort and cost data will be collected during removal and capture activities and separated by technique. Effort will be quantified as hours per deer captured or removed and all associated costs recorded for an accurate assessment of how much time and money a population-level implementation of IC and removal requires.

Relocation

All captured deer will be handled using the utmost care and concern for deer safety with the primary goal to reduce the likelihood of capture-related mortality. Deer that are manually restrained will be blindfolded and noise and handling time will be minimized to minimize capture myopathy. All captured deer will be placed in a darkened trailer for relocation. Hay and water will be placed in the trailer for bedding and food. Deer will be transported to approved relocation sites at about 11 AM following a <36-hour period in the trailer. Regardless of capture technique, at no time will drugged deer and non-drugged deer be together in the trailer and all drugged deer will be completely awake prior to relocation.

Survival and Emigration Rates

Survival and emigration rates will be determined from the literature, radiotelemetry (if deer are radiocollared), and mark-resight analysis of tagged deer (Nielsen et al. 1997*b*). Similar to distance sampling, mark-resight surveys to estimate deer presence on the study area will also provide information regarding sex and age-ratios of the population.

Efficacy of SpayVac™ in Treated Does

During the second capture season, we will draw blood from does treated with SpayVac™ during the first capture season and use an antibody assay of pregnancy-specific protein B (PSPB; Willard et al. 1999, Fraker et al. 2002) to test for pregnancy. This will allow us to determine whether SpayVac™ successfully prevented pregnancy in treated does.

Population Modeling II: Refining Estimates of Doe Contraception Rates

In December of year 2, we will use November of year 1 distance sampling surveys and survival and emigration data collected during year 1 to refine our population model and determine numbers of does to capture and contracept during the second winter. These does will include fawns born to does already pregnant when given SpayVac™ during the first winter and additional does not captured during that time.

Assessment of the Approach

Distance sampling surveys should be conducted during November of years 3 and 4 to assess whether the goal of zero population growth following initial reduction was achieved. If population abundance has increased, we will be able to determine why because all vital demographic parameters of the deer population (i.e., population abundance, births, deaths, emigration, and immigration) and human effort/success will have been quantified.

ANTICIPATED BENEFITS

This study will be one of the first of its kind: a population-level application of removal and IC in a free-ranging deer population. Our research findings will benefit communities, deer managers, and wildlife scientists in several ways. First and foremost, this study will provide much needed insight into whether a removal and IC program may be feasible for managing deer in human-developed settings. We will also gain a better understanding of the human dimensions associated with using 2 deer management methods that may not always be compatible. In short, lessons learned from this research will be directly applicable to other areas where a combination of non-lethal approaches to deer management is under consideration.

Second, our research will test the utility of an adaptive management approach to deer management, whereby data are collected and management amended based on new information. If useful, this approach should provide a template by which others can implement deer management, regardless of management technique used.

Finally, this study will provide additional data on basic deer ecology that will contribute to knowledge of deer-environmental interactions. Deer managers can use these research findings to model population dynamics and formulate urban deer management strategies. Further, vegetation can be sampled to document baseline information prior to deer abundance reduction. Floral and faunal recovery can then be monitored over time as the population is maintained at the reduced level.

DELIVERABLES

We will provide quarterly reports each study year in March, June, September, and December, and a major final report and oral presentation at the end of the study. Quarterly and annual reports will describe our progress and provide methods and preliminary results. Our final report will be a comprehensive document discussing all work and findings. Specific products from the final report will include (1) a population model for deer, (2) an assessment of our approach, and (3) research and management implications.

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APPENDIX A. FREQUENTLY ASKED QUESTIONS ABOUT SPAYVAC™ (www.immunovaccine.com).

How does SpayVac™ work?
The antigens in SpayVac™, porcine (pig) *zona pellucida* (PZP) proteins, cause a treated female mammal to produce antibodies that adhere to the surface *(zona pellucida)* of her ova (eggs) and prevent sperm from binding, thus blocking fertilization.

What is SpayVac™ composed of?
SpayVac™ is made up of 3 components: the antigen (PZP extracted and purified from pigs ovaries), liposomes (cholesterol and lecithin), and an adjuvant, to stimulate the immune response. Except for the PZP antigen, all other components have been previously approved in other vaccines. However, PZP has been incorporated into research vaccines for more than 20 years.

Does SpayVac™ affect the well-being of treated animals?
Because SpayVac™ results only in antibodies that block sperm binding, the effects on treated animals are minimal. The largest changes relate to the fact that most treated animals will not become pregnant, and in some species (e.g., white-tailed deer), repeated estrous cycles result in repeated matings. The result may be an extended breeding period and increased mating activity. Increased longevity of treated wild horses has also been reported. PZP vaccines have been used safely in wildlife and zoo animals for about 20 years and are regarded as safe.

Is SpayVac™ environmentally safe?
Unlike hormone contraceptives, which can find their way into the food chain, PZP protein antigens and the resulting antibodies are harmless to the environment. PZP antigens and antibodies are digested like any other proteins by humans, predators, scavengers, and microbes.

How much experience is there with SpayVac™?
SpayVac™ was developed in the early 1990s by scientists from Dalhousie University in Halifax, Nova Scotia, Canada. It was first tested on several species of seals and much experimental work was conducted using laboratory rabbits. In grey seals, SpayVac™ has provided contraception for at least 10 years. In a 4-year study of fallow deer and a 3-year study of white-tailed deer, SpayVac™ has been 100% effective. Studies involving domestic cats, Barbary sheep, horses, grizzly bears, and wolves are underway or have been concluded. Over the past 20 years, conventional PZP vaccines have been tried successfully in many other mammalian species.

How often do treated individuals have to be inoculated to maintain contraception?
In long-term experiments with grey seals, SpayVac™ has been effective for at least 10 years with only a single inoculation. Again, SpayVac™ has been 100% effective in fallow deer for 4 years and white-tailed deer for 3 years. Experiments with other species have not yet extended beyond 1 year. We expect that SpayVac™ will have multi-year effectiveness in most species of mammals, but the exact duration may vary according to species, adjuvant, and antigen dosage. Only testing for many years can accurately assess effective duration.

What is the difference between SpayVac™ and conventional PZP vaccines?
Conventional vaccines use PZP proteins (antigens) and an adjuvant (immune response stimulant). SpayVac™ uses exactly the same antigens and often the same adjuvant. The critical difference is that the PZP proteins in SpayVac™ are encapsulated in liposomes to protect them while they are being carried to the immune system.

Liposomes have several applications in human medicine, including Rogaine™ (a hair growth drug) and a flu vaccine that can be delivered as a nasal spray. Liposomes have been used for many years and are recognized as safe components of therapeutics. In practical terms, the most important difference between SpayVac™ and the conventional PZP vaccine is performance. SpayVac™ is the only vaccine to achieve multi-year contraception with just one administration. The conventional vaccine initially requires a primary inoculation followed by one or 2 boosters within a few weeks, with annual boosters afterwards. Although the conventional vaccine has been used in trials on deer at a number of locations, the requirement to hold animals for extended periods to administer initial boosters (or relocate and "dart" free-ranging animals) and to administer annual boosters makes the conventional vaccine generally impractical. Because only a single administration is required, SpayVac™ will be much less expensive to use than conventional vaccines and will involve much less stress for treated animals.

What is an adjuvant and which adjuvant is used in SpayVac™?
Adjuvants are materials that are incorporated into vaccines to enhance the immune response. Trials of the conventional PZP vaccine have routinely used Freund's Complete Adjuvant (FCA), which is recognized as the "gold standard" of adjuvants and is used widely in vaccine research. FCA has also been used in trials of SpayVac™. Although FCA is a very powerful adjuvant, some individual animals may respond adversely. Fortunately, SpayVac™ performs well with other adjuvants that have regulatory approval for routine use. While we may continue to use FCA for research purposes, other adjuvants, with regulatory approval, would be used in SpayVac™ formulations intended for routine use.

Will SpayVac™ provide long-term contraception with a single administration in white-tailed deer?
Although we need to conduct large-scale, multi-year trials on white-tailed deer, we believe that the answer is "YES!" We conclude this because:

- SpayVac™ with liposome-delivered PZP and an approvable adjuvant has resulted in high antibody titers and complete contraception in captive whitetails at Penn State University for 3 years.
- The conventional PZP vaccine has been proven on whitetails in numerous field and captive trials.
- SpayVac™ has worked with a single administration in all mammal species tested to date.

There is every reason to believe that SpayVac™ will also be effective in other deer species, such as elk, mule deer, and black-tailed deer. However, we cannot know the answer for certain until long-term trials are conducted. Are there limitations to using SpayVac™ to manage wildlife fertility? Yes. For the foreseeable future, it will be practical to treat only small populations that are isolated and accessible. The present state-of-the-art methods require that all treated animals be captured and marked before being treated, and this will be very difficult to achieve in most situations. Implementing population management with SpayVac™, while less expensive and less stressful on treated animals than using the conventional vaccine, will still be more expensive than culling. And in contrast to culling, contraception will not immediately reduce the number of animals.

Can SpayVac™ be safely administered to pregnant animals?
Yes. SpayVac™-elicited antibodies affect only unfertilized eggs. There is no effect on pregnancies already in progress.

Does SpayVac™ have any effect on the DNA of treated animals?
No. As with any other immune response, there is no effect on the genes of treated animals.

Does SpayVac™ work on males as well as on females?
SpayVac™ will elicit antibody production in males, but because males do not have ovaries, they do not possess eggs or *zona pellucida* proteins. Thus SpayVac™ has no useful effect on males.

How can I obtain SpayVac™ for use on deer or other wildlife in my area?
The responsibility for wildlife management generally rests with state or provincial wildlife agencies. Thus, an early step should be to consult with the appropriate people within the responsible management agency. If there is a desire to try SpayVac™, this may be possible under the provisions for field trials contained in Food and Drug Administration (FDA) rules in the USA, Health Canada rules in Canada, or the rules of the appropriate agency elsewhere. ImmunoVaccine Technologies Inc. (IVT), Halifax, Nova Scotia, Canada, is commercializing SpayVac™ for use on companion animals and wildlife. TerraMar Environmental Research Ltd., Sidney, BC, Canada, is the strategic partner with IVT for research and development of SpayVac™ for wildlife applications.

APPENDIX B.

White-tailed Deer Population Estimates

Project Final Report

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EXECUTIVE SUMMARY

Holterra Wildlife Management used distance sampling to estimate population density and abundance of white-tailed deer (*Odocoileus virginianus*) in CityOne and CityTwo during 8-10 July 2002. We divided the area into 3 separate strata for survey and estimation purposes, and sampled most intensively in CityOne and CityTwo North. We drove 30.6 miles of roads in CityOne and CityTwo North during the survey period. A total of 251 deer in 140 clusters were counted in CityOne and CityTwo North, and only 6 deer were counted in CityTwo South. Deer abundance for CityOne and CityTwo North combined was estimated to be 274 deer. Considered separately, deer abundance in CityOne and CityTwo North was 192 and 105 deer, respectively. Local deer densities were higher than most areas in the Southeast United States.

INTRODUCTION

CityOne and CityTwo are adjoining property owner associations (POAs) located approximately 6 miles west of a metropolitan area. Both POAs have recently experienced increased concern over their deer population. In July 2002, CityOne and CityTwo contracted Holterra Wildlife Management to estimate local deer population size using distance sampling. Distance sampling is not new to the field of wildlife ecology (Burnham et al. 1980). However, only recently has a rigorous theoretical basis been formulated and tested for estimating the abundance of wildlife populations using distance sampling. Numerous applications of distance sampling (formerly line transect sampling) appear in the published literature, 3 studies pertaining to large, herbivorous mammals are Gogan et al. (1986), Underwood et al. (1998), and Focardi et al. (2002).

Distance sampling is based on the theory that all deer ultimately will not be detected during ground surveys due to visual obstructions and observer error. From a sample of perpendicular distances from the objects of interest (i.e., Aclusters≅ of ∃1 deer) to a line transect (i.e., a road), a mathematical function (i.e., the Adetection function≅) is generated which describes how detection of objects changes with increasing distance from the transect. The detection function is unique to individual study areas and is estimated from distances and angles from observers to deer (Buckland et al. 1993). The area around the transect from which objects are counted can be derived from this function. Density is then computed as the number of deer encountered divided by the effective area sampled, and total population abundance calculated from this value. Herein, we discuss our distance sampling methods and results for estimating deer population abundance in CityOne and CityTwo.

METHODS

We divided CityOne and CityTwo into 3 separate strata for survey and estimation purposes: CityOne, CityTwo north of the U.S. Highway (hereafter referred to as ACityTwo North≅), and CityTwo south of the U.S. Highway (hereafter referred to as ACityTwo South≅). We sampled most intensively in CityOne and CityTwo North due to higher perceived deer densities; sampling in CityTwo South was performed to gain basic comparative information and not estimate population abundance. We conducted 2 sampling sessions during 8-10 July 2002 to observe the necessary number of deer clusters [∃60 (Buckland et al. 1993) each for CityOne and CityTwo North] to generate a robust estimate of population abundance. Independent observers from the CityOne and CityTwo ecology committees participated in deer surveys each night. We drove 30.6 miles of roads (Table 1) over the survey period in CityOne (14.0 miles) and CityTwo North (16.6 miles). In CityTwo South, we drove 7.8 miles of survey roads (Table 1).

Surveys were performed during nighttime (2100-0530 hr) hours. Observers sat on an elevated platform in the back of a pickup truck and located deer with hand-held spotlights. Observers determined distance (in yards) to the center of deer clusters with a laser rangefinder and determine angles to the center of each cluster with a truck-mounted compass. Clusters were separated using nearest neighbor criterion (LaGory 1986) and location of deer and their behavior in yards. In general, a group of deer traveling together in one yard or bordering yards were considered one cluster. We initially attempted to determine buck:doe ratios during observations. However, antlers on yearling bucks were difficult to see, so we discontinued recording these data. We also did not count fawns because they were small, poorly visible, and generally do not travel with does during July (Marchinton and Hirth 1984).

Upon collection of all field data, we used the computer program DISTANCE 3.5 (Laake et al. 1992) to estimate the detection function, population density and abundance, and precision. Estimates were derived for 3 areas: (1) CityOne, (2) CityTwo North, and (3) CityOne and CityTwo North combined. Because we did not count fawns, abundance estimates refer to the yearling and adult segment of the population only.

RESULTS

A total of 251 yearling and adult deer in 140 clusters were counted in CityOne and CityTwo North (Table 2). Only 6 deer in 4 clusters were observed in CityTwo South. Deer abundance for CityOne and CityTwo North combined was estimated to be 274 deer (Table 3). Deer abundance was higher in CityOne (192) than CityTwo North (105).

DISCUSSION

Deer densities in CityOne and CityTwo North (83 deer/mi^2) were higher than most portions of the Southeast United States. Deer at this high density may be approaching potentially problematic levels in CityOne and CityTwo, as evidenced by resident concerns about damage to gardens and ornamental vegetation. Several other deer-human conflicts can be expected if deer densities increase further. Research has shown that deer at densities exceeding about 25 deer/mi^2 begin to have significant impacts on natural ecosystems, including poor forest regeneration and loss of plant and animal biodiversity (McShea et al. 1997). Recent estimates of deer-vehicle accidents indicate that at least 5 occurred during the past 2 years in CityOne (Ecology committee, personal communication), and 11 of 249 respondents from a survey (Ecology committee, unpublished data) indicated involvement in a deer-vehicle accident during the past 3 years in CityTwo. However, deer-vehicle accidents may increase if more deer exist on the landscape. Finally, although deer observed during our surveys appeared in good physical condition, deer condition may decline if the population increases.

We observed a larger deer density in CityOne relative to CityTwo North. However, this difference is unimportant ecologically because deer in these 2 small areas are likely part of the same population. Such is true because residents have observed deer moving between CityOne and CityTwo North. Further, the typical deer home range size in this area ranges from 176 to 845 acres (Marchinton and Hirth 1984); hence, individual deer could easily overlap both CityOne and CityTwo North. Although an estimate was not derived for CityTwo South, there are clearly fewer deer there than the other areas surveyed. These results mirror a resident survey that reported fewer deer damage complaints in CityTwo South relative to the North (Ecology committee, unpublished data).

During surveys, we noted that deer were frequently associated with or close to woody cover. We counted deer in the woods or at woods edge on several occasions, and saw them in yards close to forest patches or brushy travelways that separate yards. This was not surprising given that woody cover is an essential habitat component for deer in developed areas (Kilpatrick and Spohr 2000, Grund et al. 2002), providing food and especially cover. However, we also observed deer in yards or larger areas free of woods or brush. In several instances, deer were bedded in open yards or next to houses.

Additional anecdotal information gathered during observations provided insight into the deer population in CityOne and CityTwo. Although not included in the abundance estimate, spotted fawns were seen on several occasions, indicating adult does reproduced earlier this year. As aforementioned, deer appeared in good physical condition and no injuries or abnormalities were noted. Deer were also very approachable and frequently stood still while we stopped the vehicle and collected data. Fifty of the 140 deer clusters observed (35%) were within 30 yards of the road, indicating deer would be very accessible for management purposes.

In conclusion, distance sampling provided a very precise estimate of deer population abundance in CityOne and CityTwo, where precision refers to how frequently an estimation procedure would result in a similar average value after repeating the procedure many times under the same conditions (Lancia et al. 1994). A common measure of precision is the coefficient of variation (CV), which is the standard error (the square root of the variance, or the average of the squared deviations between a population estimate repeated many times and its expected value; Lancia et al. 1994) divided by the average. The CV for these estimates were 10-12%, which is excellent for estimates of wildlife abundance.

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Table 1. Roads driven during distance surveys used to estimate deer population abundance in CityOne and CityTwo. Deer surveys were performed by Holterra Wildlife Management during 8-10 July 2002.

Roads Driven		
CityOne	CityTwo North	CityTwo South
Bamberg	Amberly	Clubhouse
The Oaks	The Point	Fairway
Belmont	Canters	Greenwood Court
Cumberland	Cottingham	Greenwood Drive
East Summerton	Deer Run	Sorrelwood
Edisto	Fox Meadow	Whiteoaks
Hunting	Ghost Pony	Wood Eden
Kershaw	Longview	
Lexington	Martingale East	
Manchester	Martingale West	
Oconee	North Lake	
Richland	Oxen	

Summerton	Plantation House
Tidelands	East Drive
	West Way
	Rosebud
	Spartina Crescent

Table 2. Deer clusters observed during distance sampling surveys used to estimate deer population abundance in CityOne and CityTwo. Deer surveys were performed by Holterra Wildlife Management during 8-10 July 2002.

Area	Deer clusters counted	Total deer counted	Average cluster size (∀ standard error)	Range of deer per cluster
CityOne	70	137	1.96 ∀ 0.17	1 - 7
CityTwo North	70	114	1.63 ∀ 0.11	1 - 4
CityOne and CityTwo North	140	251	1.79 ∀ 0.11	1 - 7
CityTwo South	4	6	1.50 ∀ 0.29	1 - 2

Table 3. Deer population estimates from distance sampling surveys in CityOne and CityTwo. Deer surveys were performed by Holterra Wildlife Management during 8-10 July 2002. The 90% Confidence Interval (CI) refers to being 90% confident that the estimate falls within the given interval.

	Population density			Population abundance	
Area	Estimate	90% CI	Area (mi^2)	Estimate	90% CI
CityOne	107.60	90.91 - 127.35	1.78	191.53	161.82 - 226.68
CityTwo North	68.47	54.07 - 86.71	1.53	104.76	82.73 - 132.67
CityOne and CityTwoNorth	82.82	64.89 - 105.71	3.31	274.13[a]	214.79 - 349.90

[a]Note: this estimate is not simply an addition of the separate estimates for CityOne and CityTwo North because it is based on all 140 cluster observations.

APPENDIX C. TIMETABLE FOR DEER STUDY

Year – Month(s)	Activities
Year 1	
	Distance sampling to estimate pre-study population abundance Pre-baiting activities (for capture purposes) and familiarization with study areas Population modeling
November	Coordinate with veterinarian for upcoming capture activities
December – March	Capture does using darting and drop nets, relocate necessary number of deer Upon immobilization, give hand injection of Spay-Vac™ Weigh, measure, and inspect deer for physical condition status Fit deer with numbered eartags and tags marked "not for consumption" Remove required number of unmarked deer (both bucks and does)
Year 2	
November	Distance sampling and pre-baiting Refine population model
December – March	Same capture activities as during Year 1, treat does with Spay-Vac™
Years 3 & 4	
November	Distance sampling
December – June	Final report preparation
July	Final report completion and presentation

APPENDIX D. DESCRIPTION OF HOLTERRA WILDLIFE MANAGEMENT.

Address: Holterra Wildlife Management, Box 330907, Nashville, TN 37203; phone/fax: 615-297-7776; www.holterra.com; info@holterra.com

Purpose: Holterra Wildlife Management is a consulting firm operated by professional wildlife ecologists that specialize in urban deer research and management. Holterra is comprised of 3 primary wildlife ecologists, Dr. Clay Nielsen, R. Gray Anderson, and Frank Verret.

Education: Dr. Clay Nielsen; Certified Associate Wildlife Biologist, The Wildlife Society

- Ph.D. in Zoology, Southern Illinois University at Carbondale
- M.S. in Environmental and Forest Biology, SUNY College of Environmental Science and Forestry
- B.S. in Natural Resources, University of Nebraska-Lincoln

Education: Gray Anderson; Certified Associate Wildlife Biologist, The Wildlife Society

- M.S. and B.S. in Biology, Tennessee Technological University

Education: Frank Verret

- B.S. in Zoology, B. S. in Chemistry, University of Southwestern Louisiana

Computer and Data Analysis Skills

- database management; experimental design; geographic information systems; habitat modeling; population estimation; radiotelemetry, home range, and movement data analysis; population modeling; statistical analysis; survival analysis

Field Skills

- aerial and ground-based radiotelemetry; aerial photo interpretation; bird and mammal capture, handling, and immobilization; bird banding and identification; collection of reproductive and physical condition data from animal necropsy; deciduous vegetation sampling techniques; deer population estimates via distance sampling, helicopter surveys, mark-resight monitoring, and pellet counts; global positioning systems; harvest management; invertebrate surveys; plant identification; waterfowl surveys

Publications and Presentations

>10 papers in peer-reviewed journals, including the Journal of Wildlife Management, Wildlife Society Bulletin, Biological Conservation, and American Midland Naturalist

>20 major technical papers and reports to granting agencies

>40 invited presentations

Subj:	**Deer Management Info**
Date:	11/13/2003 7:51:40 PM Central Standard Time
From:	gray@holterra.com
To:	willhenrym@aol.com
File:	**holterrainfo.zip** (28197 bytes) DL Time (44000 bps): < 1 minute
Sent from the Internet (Details)	

Mr. Mangum -

I appreciate the information about the deer management problems in Hollywood Park. Attached are several documents that should assist you and the deer committee. I have transferred the files to Word from WordPerfect and I hope no glaring errors have shown up. If there are problems I can fax any or all documents. The Excel file has some basic cost estimates that are best interpreted on a monthly basis. Some projects will be short and likely cost less than represented (sharpshooting) but others (trap &relocate/euthanize) will likely take the entire winter and maybe even into a second year.

As for availability, we can assist Hollywood Park with deer management this winter. Starting with population estimates, to management plans, and final projects implementation we are here to help the entire way.

I hope this information helps. Please do not hesitate to call if you need any additional information.

Sincerely,
Gray

R. Gray Anderson
Holterra Wildlife Management
Box 330907
Nashville, TN 37203
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Holterra Wildlife Management

"Balancing emotion with science in the urban deer management process"

Urban deer management is a complex issue facing many communities. However, communities often begin managing their deer population without the appropriate guidance or wait until a crisis has developed. As a result, major conflicts have arisen among community factions that are often not resolved for years, thereby, wasting incredible amounts of time and money and pitting once-friendly neighbors against each other. Clearly, help is needed to prevent communities from becoming divided over deer management issues.

Enter Holterra Wildlife Management. We are a consulting firm operated by professionally certified Associate Wildlife Biologists that helps communities develop long-term solutions regarding deer management. Our goal is to save communities time and money by providing the individual guidance and attention necessary for decision-making long before a crisis develops. Holterra advocates the following process as the appropriate model for urban deer management, and can provide communities these services.

Step 1: Present educational and informational seminars. Holterra presents seminars that provide the public an understanding of deer biology, including factors influencing births and deaths which ultimately affect population growth. We also discuss methods to solve problems with overabundant deer populations, including both non-lethal methods (i.e., habitat management, fencing, and use of repellents) and lethal methods (i.e., managed hunts, sharpshooting, and trapping and euthanization).

Step 2: Survey human attitudes. Holterra creates and administers scientific surveys of human preferences for appropriate deer population sizes and attitudes regarding deer damage. Knowledge of this information is important for setting future deer population goals.

Step 3: Develop a citizen task force. Holterra assists in establishing councils of local residents that represent multiple factions in the community. Citizen task forces can then be advisors to local community officials and be primary advisors in the decision-making process.

Step 4: Estimate number of deer in the community. Holterra uses distance sampling, widely regarded as the most unbiased population estimation method possible, to estimate deer population size. This estimate is then used as the basis for all other management decisions and is crucial for determining future population goals.

Step 5: Determine whether the number of deer present is problematic. This is a decision that must be made based on community desires, as identified in the human attitudes survey and from citizen task force input. If the number of deer is deemed to be too many, Holterra can help the community determine which methods may be preferable to reduce population size.

Step 6: Create a long-term plan to focus deer management. Holterra develops management plans incorporating the aforementioned components to provide long-term solutions regarding urban deer management. Holterra can implement certain management methods, as well.

If you are interested these services or have further questions, please contact:
Holterra Wildlife Management, Box 330907, Nashville, TN 37203
615-297-7776, 888-397-4466, e-mail: info@holterra.com, website: www.holterra.com

Using Distance Sampling Versus Aerial Surveys to Estimate Deer Population Size

Prepared by
Holterra Wildlife Management
P.O. Box 330907
Nashville, TN 37203

This document describes using distance sampling versus aerial surveys for estimating deer population size. Listed are procedures for both methods and a discussion of the advantages of using distance sampling rather than aerial surveys.

Distance Sampling Methods

Distance sampling (Buckland et al. 1993) is based on the theory that all deer ultimately will not be detected during ground surveys due to visual obstructions and observer error. From a sample of perpendicular distances from the objects of interest to a line transect, a mathematical function (i.e., the "detection function") is generated which describes how detection of objects changes with increasing distance from the transect. The detection function is unique to individual study areas and is estimated from distances and angles from observers to deer. The area around the transect from which objects are counted can be derived from this function. Density is then computed as the number of deer encountered divided by the effective area sampled.

Distance sampling is used by several thousand registered users in >100 countries to survey populations of >60 different species. Specific agencies in the United States that use distance sampling include: (1) National Parks Service, Capital and Midwest regions; (2) United States Department of Agriculture, Wildlife Services; (3) California Marine Consortium; and (4) state agencies in Utah and Colorado.

Aerial Survey Methods

Aerial surveys utilize observers in fixed-wing aircraft or helicopters to count deer on the ground from elevations of 50-100 meters. Either the entire study area is surveyed via line transects or a subset of the study area is counted via survey blocks. If the entire area is surveyed the total deer count is used as a census and all deer are assumed to have been counted on the study area. If survey blocks are employed, statistical analysis is used to derive a mean population estimate with associated error.

Disadvantages to Using Aerial Surveys

There are several disadvantages to using aerial surveys to estimate deer population size. First, aerial surveys require adequate snow cover (>6 inches) uniformly distributed across the landscape during the entire sampling period. This dependence on snow cover restricts utility of this method to a very narrow winter period for many portions of the U.S. Any patches of soil not covered by snow will hide deer; hence, without snow cover, deer detection rates are only 36-75% (DeYoung 1985). Second, visibility of deer is made difficult by thick ground cover. Brushy areas or dense conifer stands will conceal deer, and even though a plane or helicopter is flying over, deer may hide in these areas and not be observed. Third, even with complete snow cover and high deer visibility, aerial survey estimates often underestimate number of deer on the ground by >20% (Beringer et al. 1998). Hence, the primary problem with aerial surveys are that deer are missed, and frequently the proportion missed is entirely unknown.

Advantages to Using Distance Sampling Rather than Aerial Surveys

Distance sampling avoids the disadvantages of aerial surveys. First and most importantly, use of distance sampling allows deer to be missed during surveys. Second, these surveys can be performed at any time during the year because they are not dependent on adequate snow cover or other weather conditions. Third, ground surveys are usually cheaper than aerial surveys, requiring less labor and no expensive air time.

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YEAR 1: Trap and Relocate			
BUDGET CATEGORY	**Early Oct 2003**	**Oct 03 - Feb 04**	**Yr 1 Total**
	Population Estimates	Capture & Euthanize	
Labor			
Biologists	3000	42000	45000
Deer carcass processing - local vendor		7500	7500
Travel			
Vehicles (vehicles * lease * months)		6000	6000
Travel and Lodging		5000	5000
Commodities			
Equipment and Capture Drugs		5000	5000
Misc. Supplies (tags, other gear)		3000	3000
	3000	**68500**	**71500**

15 per hr. Tech

6-8 Stop shot on Dart

Introduction to Capture and Relocation of Urban Deer

Capture and relocation is one of several methods available to manage overabundant urban deer populations (Ellingwood and Caturano 1988). Capture and relocation techniques are often endorsed by community residents because they are perceived as safe to humans and provide a non-lethal means of deer management. For example, capture and relocation was indicated as the preferred method of deer management for residents of a St. Louis suburb (Town and Country) in a 1996 survey (Stout 1997). However, this survey also indicated that residents there knew relatively little about these techniques. This guide provides a detailed description of the basics of deer capture and relocation. The capture techniques commonly used in urban deer management programs are described along with a thorough evaluation of each based on humaneness to deer, suitability for use in urban settings, and total cost. Finally, mortality rates of relocated deer in general are discussed. These considerations should aid local officials and conservation committees in choosing capture techniques that best fit their community.

Initial Considerations

Success of a deer capture and relocation program depends on several components that need to be considered prior to implementation. First, an appropriate number of capture sites need to be used; often sites must be widely-distributed to ensure appropriate management throughout the community. This is dependent primarily upon the number of landowners willing to cooperate, which must be determined early in the program. Access to these areas must be gained to allow pre-baiting and determination of localized deer numbers. Because areas can become "trapped out" and deer may become trap-wary following trap exposure, the opportunity to capture deer on previously untrapped areas will increase success. Further, capture success is frequently dictated by weather and deer physical condition; malnourished deer or those enduring severe winters tend to be more susceptible to capture over bait. Therefore, multiple capture techniques may be needed to maximize success.

Deer Capture Techniques

Several techniques are commonly used to capture urban deer. These techniques can be broken down into the three main groups detailed below. Basically, all capture methods are similar in terms of deer transport and relocation; deer are placed onto a truck or flatbed trailer and released at relocation sites. However, basic operational differences exist among methods that must be considered.

Group 1: Trapping Procedures

Box traps are commonly constructed of wood and measure 8-12 feet long x 4 feet high x 4 feet wide with a sliding trap door on each end (Masters 1978, Palmer et al. 1980). Deer enter the trap to feed on bait (usually corn or apples) placed in the middle of the trap and are captured when the trigger wire is tripped and the sliding doors close. Deer are then handled in one of two ways. First, deer may be released into crates; this does not require direct human handling or sedatives. An alternate approach is to release deer into a large net, which effectively restrains the animal (Grund 1998). At this point, sedatives may or may not be used.

Clover traps are made of piping walled with netting [42 x 66 inches in dimension (McCullough 1975)]. They has one gate that closes when triggered by deer seeking bait (Clover 1954). Clover traps can be collapsed to keep deer from jumping about upon approach of people, or deer can be released into a small net and then handled. Similar to box traps, deer may be sedated or simply restrained using a restraining device.

Group 2: Netting Procedures

Drop nets are large nets (sometimes 70x70 feet) suspended by several poles (Rongstad and McCabe 1984). Once baited underneath, the net is released and dropped on deer seeking bait. *Rocket nets* are 40x60-foot mesh net propelled over deer by three rockets. Rockets are fired from steel poles 5 feet above the ground, pulling the net that had been folded below the rocket poles over deer (Hawkins et al. 1968). Deer are then handled and either sedated or restrained.

Group 3: Darting Procedures

Darting of deer can be performed with specially-made guns that project small sedative-containing darts into portions of the deer containing abundant muscle tissue, such as the flank. Darting is most effective within 50 yards and can be done over bait piles or opportunistically from a vehicle. Because deer are not in a net or trap, deer must be recovered away from the darting site. Usually, deer become completely sedated relatively close (within 100 meters) to the shooting site and can be recovered quickly with the use of transmitter-equipped darts (Kilpatrick et al.1997) or by continuously observing the deer until the drug takes effect (Grund 1998).

Evaluation of Capture Techniques

A comprehensive evaluation of capture techniques requires three critical considerations: (1) humaneness to deer, (2) suitability for use in given urban settings, and (3) total cost. Which component is most important to a particular community will depend on several items, such as budgets and concern over conspicuousness of capture techniques. However, for many affluent communities, humaneness of technique will be the most important factor to consider (Stout 1997).

Humaneness to Deer

Comparisons among capture techniques will be based upon studies that did not relocate deer, but rather simply released deer on-site. Therefore, capture-related mortalities discussed in this section do not include post-relocation mortality.

Humaneness to deer can be considered based on how deer are handled and the risk of deer mortality resulting from capture. Whether deer are sedated does not necessarily influence humaneness. Sedation has been proven in numerous studies to promote safety for deer and human handlers without causing mortality. In general, deer will try to flee when in any kind of trap or net. However, when deer are darted, they often never see the humans involved in the process. Further, they are not restrained in any way upon capture, but simply fall asleep.

Anytime humans handle deer, the risks of injury and mortality increase substantially. Deer may succumb to two primary types of mortality, those resulting directly from capture, or from capture myopathy. In general, studies have reported rates of capture-related mortality ranging from 0-33%; however, most studies provide rates of <15% (Table 1). Box and clover traps and drop nets report capture-related mortality rates of <10%, and each trapping technique had one study of where mortality was zero (Table 1). Although Hawkins et al. (1967) reported no capture-related mortality with rocket nets, other studies generally have >10% mortality (Table 1). Early darting studies found relatively high capture-related mortality rates; however, the most recent study reports zero mortality (Table 1).

Capture myopathy is a stress-related disease that results in delayed mortality of captured deer. Radiotracking deer after capture is necessary to study capture myopathy, and very few studies provide such information. Beringer et al. (1996) provide the only definitive study of capture myopathy, using both clover traps and rocket nets. They found mortality rates from capture myopathy of 11% for rocket nets and 0% for clover traps. However, he provided methods to reduce capture myopathy for rocket netting, including capturing fewer than three deer per netting episode. Whether capture myopathy is prevalent using other methods, such as darting or box traps is entirely unknown. However, it appears that techniques where deer are restrained longer may make deer more susceptible to capture myopathy (Rongstad and McCabe 1984)

Suitability in a Given Urban Setting

Suitability of a deer capture technique in a given setting can be determined based on (1) ease of operation set-up and movement, (2) inconspicuousness, (3) inability to be tampered with, (4) allowance of a surgical approach to management, and (5) insensitivity to weather conditions. In general, clover traps are easier to set up and move than box traps and drop nets. However, darting procedures allow for the most mobility and only require driving from one site to the next. Nets and traps are relatively large and conspicuous, and are easily tampered with or vandalized by those opposed to deer management programs; whereas darting operations are relatively discreet. Although nets require relatively large, open areas to capture deer, both traps and darting procedures have great ability to provide a surgical approach to deer management on small properties. Further, certain traps may be efficient only during periods of snow cover (Beringer et al. 1996). Therefore, if winters are warm, other methods such as darting may be more effective. However, because partially sedated deer may run onto roads, darting would be best in parks or larger acreages.

Total Cost

Total cost of capture techniques are determined based on human effort multiplied by per-hour or per-deer cost. Although several wildlife studies have gathered data to address these matters by providing estimates of effort, these studies often show inconsistent results (Table 1). Further, estimates of effort are not directly comparable because of differences between study areas and techniques of individual researchers. For example, study areas differ in terms of deer numbers. Capture and relocation operations generally will require less effort if deer numbers are higher; further, in these areas deer may be in poorer physical condition and more susceptible to baiting. Second, individual differences among capture techniques in terms of number of traps used and their placement about the community may result in contradicting estimates of success. In general, netting procedures can provide the most deer per capture, but often require larger handling teams than traps (2-4 people) or darting (2 people). However, this does not always equate to greater capture success. Three studies have compared several capture techniques, and results differ among them (Table 1). Hawkins et al. (1967) found that corral traps (not discussed here) were the most effective, Palmer et al. (1980) had highest success with box traps, and

Ishmael and Rongstad (1984) reported that darting was most efficient (Table 1). Therefore, the cost and potential efficacy of each technique is best judged on a community-by-community basis.

Post-relocation Mortality

Of further concern is mortality of deer upon relocation. Given that deer released on-site may succumb to capture myopathy, it is impossible to determine whether relocated deer that die would have died if released at the capture site. However, relocated deer may be predisposed to other mortality factors based on the unfamiliarity with food, water, cover, roads, and other hazards when released into new environments. Commonly, mortality rates of relocated deer range from 55-85% during 4-15 months post-relocation, based on radiotracking studies (Ellingwood and Caturano 1988, Ishmael et al. 1995). However, whether mortality rates of relocated deer differ from other urban deer or deer on the surrounding rural landscape is unclear because control studies within the same area are rarely performed.

Conclusions

In conclusion, a multi-faceted approach entailing use of more than one capture technique is likely necessary for successful deer management in many communities. For instance, over larger areas, drop nets or rocket nets may be useful; whereas, for smaller properties, trapping and darting may be employed. In fact, although rarely used, darting may provide a viable management alternative because it allows high mobility of human handlers, does not restrain deer upon capture, is not subjected to tampering, and is the least sensitive to weather conditions that may keep deer from seeking bait. Because capture methods may be relatively similar in costs and humaneness to deer, areas available for capture activities may be the most important determinant of which capture technique is going to best achieve population goals. Therefore, early contact of landowners to obtain permission for capture operations and appropriate placement of techniques to address site-specific damage concerns is essential to guide appropriate urban deer management.

Table 1. Comparison of capture-related mortality and efficiency of deer capture techniques. Efficiency estimates do not include time spent relocating deer.

Technique	Reference	Capture-related Mortality (%)[a]	Capture Efficiency
Box Trap	Hawkins et al. (1967)	0	1.3 hr/deer[b]
	Palmer et al. (1980)	2	2.8 hr/deer
	Peery (1968)	8	13.6 hr/deer
	Ishmael et al. (1995)	5	range = 13.2-29.7 hr/deer[c]
Clover Trap	Ishmael and Rongstad (1984)	0[d]	43.9 hr/deer[e]
	Naugle et al. (1995)	not reported	2.8 trapnights/capture
	Jordan et al. (1995)	not reported	37-40 captures/100 trapnights during bad winters, otherwise 14 captures/100 trapnights
	Beringer et al. (1996)	5	not reported
Drop Net	Conner et al. (1987)	7	2.1 hr/deer
	DeNicola and Swihart (1997)	0	3.9 hr/deer
Rocket Net	Hawkins et al. (1968)	0	not reported
	Palmer et al. (1980)	24	6.9 hr/deer
	Beringer et al. (1996)	0	not reported
Darting	Hawkins et al. (1967)	20	7.5 hr/deer
	Ishmael and Rongstad (1984)	33	20.5 hr/deer
	Palmer et al. (1980)	14	4.1 hr/deer
	Kilpatrick et al. (1997)	0	4.4 hr/deer

[a]Includes accidental capture mortality only, and not deaths due to capture myopathy.
[b]Includes live deer only; all other estimates include deer that died during capture.
[c]Cost of $303/deer captured.
[d]Only 2 deer captured.
[e]Cost of $570/deer captured.

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WHITE BUFFALO, INC.

REVIEW OF AVAILABLE TECHNIQUES

When regulated hunting is not an option, nontraditional methods, such as the ones identified below, can be implemented to address overabundant deer populations. Further review of these techniques can be found in ***Managing White Tailed Deer in Suburban Environments:A Technical Guide***

Trap and Relocate

This approach requires trapping, netting and/or remote chemical immobilization by experienced personnel. Costs can range from $400 to $2,931. Suitable release sites are necessary, but can be difficult to find. Relocating deer can result in stress-related death, or disease transmission (i.e., Lyme Disease, tuberculosis). If selected, then personnel experienced in handling procedures should be used to minimize stress and post-release death.

Fertility Control

Perceived to be the ideal solution, fertility control agents are currently not available for managing overabundant deer populations. All field studies are strictly regulated by the Food and Drug Administration and further research is required to assess the feasibility and practicality of using contraceptives. Fertility control agents exist that can prevent reproduction in individual deer. However, the need for repeated administration and limited delivery technologies significantly restrict the population size that can be experimentally manipulated. Data collected to date (cost of manpower and materials (~$1,000/per doe treated), adequate number of does accessed) suggests that use of contraceptives will be limited to small insular herds.

Sharpshooting

Approved by the American Veterinary Medical Association (AVMA) as a humane form of euthansia, sharpshooting requires trained personnel to use a variety of techniques to maximize safety, discretion and efficiency. This method is often implemented in suburban and urban settings with access to both public and private lands. Costs range from $91 to $300 per deer. Typically all meat harvested is donated to area food shelters for distribution.

Controlled Hunting

An expansion of legal regulated hunting methods, controlled hunts can be successful. Using hunters to manage overabundant deer populations may require the need for state agency and law enforcement involvement as there is the potential for animal welfare groups intervention. Costs range from $162 to $622 per deer harvested depending on the manpower required. Archery is a discreet removal technique, however, lower success rates because of limited shooting ranges may require a longer time frame of operation. Firearms, when feasible, can be used to maximize the efficiency (number of deer harvested, length of program).

Trap and Euthanasia

This technique can be used in areas where there is a concern about or law prohibiting the discharge of firearms. Physical restraint, using box traps, clover traps, drop nets or rocket nets, is followed by euthanasia using a gun shot or captive bolt to the head. As mentioned above, deer are subjected to great amounts of stress during the restraint component. Minimum cost is $400 per deer.

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Inquiries and Information to: WBUFFALOINC@aol.com

Subj:	**Hollywood Harvest (Venal Que La Gloria)**
Date:	12/5/2003 1:38:49 PM Central Standard Time
From:	rhallenbeck@austin.rr.com
To:	willhenrym@aol.com
Sent from the Internet (Details)	

Will,

In response to our recent conversations regarding the decimation of the deer population in Hollywood Park, Hill Country Deer Processing respectfully submits the following:

		$/Deer
1	Trapping:	35
2	Kill	10
3	Field Dressing	15
4	Transportation	15
5	Processing	35
Total		$110

This fee will come down commensurately 10% per 100 deer taken by HCDP. This assumes that we will bring the whole deer carcass to HCDP in Fredericksburg and distribute the meat among the needy in Gillespie County. We may donate to other surrounding counties as we see fit.

If you need more explicit information, please do not hesitate to email so that we leave a time/date stamp and a paper trail.

The above assumes full cooperation by the City of Hollywood Park, the police and all facilities pertaining to the harvest.

Thank You,

Rob Hallenbeck
Based on these figures, we can negotiate downward based on the total number of deer taken by HCDP.

12/02/03

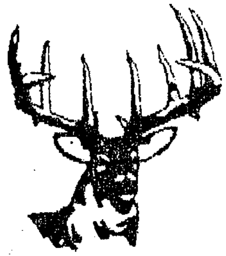
To Whom It May Concern:

I have been trapping deer for 8 years throughout Texas. I have assisted Lakeway for 5 years in trapping and transporting their deer. I have also assisted Horseshoe Bay in 2002 for removal of deer. My fee for the services we discussed will be $50.00 per animal. The services will include erecting the net, operating the net, assisting in the capture of the deer, and transporting them to the processing plant. This fee is contingent on Sun Harvest Farms in Johnson City being the drop off location. This location is convenient and allows me to offer you a better rate. It is my understanding that you have an over population of deer. In my past experiences (such as Lakeway) I have had a percentage of the deer tested for Lime disease. A small percentage of those tested were positive. This proposal is good for 90 days.

Please let me know if I can be of service to your community.
Feel free to contact me if you have any questions.

Sincerely,

James Bonds
Cherokee Ranch
(512) 894-4044



JIM BRUNER
16026 S. STATE HWY. 16 • FREDERICKSBURG, TEXAS 78624-9487 • OFFICE/FAX (830) 997-7213

December 12, 2003

Mr. Will Mangum, Chairman
Hollywood Park Deer Committee
Hollywood Park, Texas

Dear Mr. Mangum:

Thank you for the opportunity to provide your committee with a proposal for the removal of deer from Hollywood Park. As you may or may not know, I have been involved with the problem in Hollywood Park since 1993 and have steadily watched as the problem has reached crisis proportion. Hopefully with your efforts these problems will become manageable.

As per your request:

1. As per TPW regulations regarding TTT of deer please submit a price for the trap, transport, and transplanting of deer from Hollywood Park to locations up to 100 miles from San Antonio, TX.

Your inquiry does not specify as to the method to be used. Being somewhat familiar with the City and your residents mixed feelings with regard to the removal of the deer I will propose a price based on the final number of deer removed by either drop net, tranquilizer gun, or "catch facility". 0-100 deer $100.00 ea., 100-200 deer $90.00 ea., 200-300 deer $80.00 ea. Transportation costs are included in the above price quote up to 100 miles from San Antonio. After 100 miles from San Antonio the transportation costs are $1.50/loaded mile.

2. As per TPW regulations regarding TTP of deer please submit a price for the trapping and transporting of deer from Hollywood Park to local processors and a separate price to processors no more than 70 miles from San Antonio, TX.

Again, your inquiry does not specify as to the method to be used. Needless to say the method, time involved, and catch cost does not vary whether the deer is caught for TTT or TTP. Consequently the costs proposed under item one will also be appropriate for item number 2.

With regard to the "processor" I would like to provide you with the following observations. After having spoken with Ms. Copeland with regard to this matter I personally visited several "processors" in order to determine their suitability for this undertaking. I visited 1) Hill Country Deer Processing, owned by Rob Hallenbeck, in Fredericksburg, 2) Dutchman's Market, Fredericksburg, and 3) Harvest House Farms, in Johnson City. Of the three only Harvest House Farms in Johnson City has the appropriate facilities in my opinion to undertake this project. In fact, they are the facility Lakeway has chosen for their processing. With this in mind my proposal will only include the transportation and processing if done by Harvest House Farms in Johnson City. This is based on the appropriateness of the facility with regard to the humanness of the animal slaughter. Once again the transportation will be included in the above price to Harvest House Farms in Johnson City.

3. As per TPW regulations regarding the use of Sharp shooting, please submit a price for your services and the methods you intend to use.

The use of sound suppressed equipment in populated areas has a totally different sets of parameters in the realm of deer removal. Unfortunately I believe that the residents of Hollywood Park are not prepared for this alternative at the present time and I do not wish to include a proposal on this method at the present time. I will however be available to present your committee, the City Council, and the residents of Hollywood Park an overview of this method. My consultation fee on this subject is $50.00/hr. and $.50/mile roundtrip.

I hope the information I have provided will assist you in your control decisions. If I can be of any assistance, as always, do not hesitate to contact me. I sincerely hope your efforts will result in the reduction of your critically high population of whitetail deer.

Sincerely

James B Bruner

James B. Bruner
Certified Wildlife Biologist